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ABSTRACT

A semantic differential processing system was designed to economically facilitate the collection and analyses of large amounts of data. The collection form was designed on an optical scanning form which may be overprinted with random orderings of concepts, scales, and scale polarities. A FORTRAN program "unscrambles" the scale responses. The output includes an interconcept D-matrix for the semantic space and each dimension. The reordered responses are punched in a deck for input to other analytic programs. (Author)

A SEMANTIC DIFFERENTIAL PROCESSING SYSTEM

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Paper presented at American Educational Research Association, Chicago, Illinois, April, 1972.

ABSTRACT

A semantic differential processing system was designed to economically facilitate the collection and analyses of large amounts of data. The collection form was designed on an optical scanning form which may be overprinted with random orderings of concepts, scales, and scale polarities. A FORTRAN program "unscrambles" the scale responses. The output includes an interconcept D-matrix for the semantic space and each dimension. The reordered responses are punched in a deck for input to other analytic programs.

A SEMANTIC DIFFERENTIAL

PROCESSING SYSTEM

INTRODUCTION

Flexibility is the byword to data processing in a large urban school system. The typical "one shot" solution mode becomes almost impossible because of the large volume of "regular" demands upon data processing resources. There are simply insufficient personnel, equipment, and hours to be able to produce a "one shot" solution for every problem that develops in educational research. One mode of problem solution is to design a system that has the flexibility to meet the parameters of many "one shot" problems. This is what we have tried to do in designing a semantic differential processing system.

OBJECTIVES

1a. Economy

It was essential that the system be economical - that is, the entire system should function with a minimum of clerical operations and preferably it should function entirely on data processing machines.

1b. Large volume processing

The system should be able to handle large quantities of data in terms of numbers of respondents and in terms of the number of responses per respondent.

1c. Age range of respondents

The system should be able to accommodate first grade pupils to adults.

2. Reduction of response set effects

The system should accommodate reduction of response set effects by randomizing ordering of scales and concepts and polarity of scales.

3. Independent variables

The system should incorporate coding of independent variables to facilitate research design analyses.

4a. Semantic differential outputs

The system should produce output displays which are interpretable by the researcher and contribute to his understanding of the information being developed by the system.

4b. Output data for analyses inputs

The system should provide outputs which may be used as inputs to other analysis systems such as multivariate analysis of variance and factor analysis programs.

METHODS

1. Design of data collection forms

Since the School District of Philadelphia leases an OpScan 100 for processing of various data forms, OpScan forms were chosen. The OpScan 100 processes forms rapidly enough to facilitate economical processing of masses of data while allowing a high level of flexibility in the layout of forms.

It was desired to accommodate three different age groups of respondents: primary grades, intermediate grades, and secondary level pupils. Three basic forms were designed: a scale length of three for primary pupils, five for intermediate pupils, and seven for secondary pupils and adults.

Regardless of scale length, each form contained response areas for four concepts with nine scales for each concept. In addition, each form contained an area for subject ID, concept ID, and design (independent variable) codes.

The forms were designed with the areas for subject ID, concept ID, design codes, concept labels, scale adjectives, and response blocks preprinted. The forms could then be overprinted, using offset printing, with the desired concept labels and scale adjectives. This procedure allowed the researcher complete freedom in choice of concepts and scales for a given form page.

2. Randomization of concepts and scales

It was desired to reduce effects of scale order, concept order, and constant polarity of scales by allowing random ordering of concepts, scales, and scale polarities. The overprinting feature permitted such randomization up to a limit of forty page variations. It was possible to overprint several rearrangements of the same concepts and scales so that orders of presentation could be varied within a given study sample. Different subjects within the same sample could be presented the same concepts and scales but in different orderings. The reorderings could be completely random or systematic as desired. Maximums of twenty eight concepts, nine scales, and forty rearrangements or "pages" were accomodated by the analysis program.

3. Independent variables

Four fields were provided for coding independent variables. These included grade level, sex, pupil ID, and treatment code. In addition, two form indexing fields were provided, "page sort" and "page code." The four independent variable fields could be used as desired by the researcher. The "page sort" field was used by the analysis program to identify the concept and scales of a given page form. These "page sort" values must begin with 01 and continue up to a maximum of 40. The program used this value as an index to enter the "unscrambling" key in order to properly process the scales and concepts on the page.

4. Data reduction and analysis

Once the forms were completed by the subjects they were processed on an OpScan 100 Optical Reader. Each form produced a punched card containing the independent variable information and the subject's responses on thirty-six scales, usually nine scales on each of four concepts. Up to seven forms (twenty-eight concepts) could be accommodated per subject. There was no limit on the number of subjects included.

A FORTRAN program was written which read each card, identified the page, and assigned its responses to the appropriate scales and concepts. The program accepted the cards in random order, reordered, and repolarized the scale responses and assigned them to their concept as specified by the researcher with parameter cards.

The following list shows the program's overall logic in major component form:

1. START: Read and print comments, problem description, labels for scales, concept and factors specified.

2. PARAMETERIZATION: Concepts, scales, factors, scale length, number of observations, and various options are specified. (Also included are diagnostic test of these parameters.)

3. INITIALIZATION OF MATRICES TO 0.

4. DATA READ, SORT AND ACCUMULATION: Data from each card is read and sorted based on parameter specification. If, for example, a particular scale is identified as having reversed polarity, a complimenting transformation takes place. After sorting, each cell in the data matrix is accumulated and contains average scale scores for each concept. These averages are then printed.

5. COMPUTE CONCEPT AVERAGES: Concept averages are computed for each factor and may be printed.

6. COMPUTE D MATRIX: A matrix of Pythagorean distances between concepts is generated for: a) each factor; and b) a generalized semantic space with as many dimensions as there are factors. Each matrix is printed.

7. OPTIONAL OUTPUT OF REPOLARIZED AND REORDERED SCALE RESPONSES (in card form for further analysis).

It was assumed that the researcher had previously determined that the semantic space of interest contains three or fewer orthogonal dimensions and that a maximum of nine scales were used to determine the space. As many independent problems as desired may be submitted with one pass of the program.

RESULTS

The program produces an interconcept distance matrix[1] for each dimension and for the three dimensional semantic space. The single dimension interconcept distances are the differences of concept means and are reported in the upper half of a concept by concept matrix. (The mean differences may be negative.) The mean differences are squared and accumulated in the lower half of the concept by concept matrix. The square root of the accumulated mean differences are the semantic space interconcept distances and are reported in the lower half of the final matrix. These distances are computed by:

$$D_{jk} = \sqrt{\sum_{i=1}^{n} (\overline{X}_{ij} - \overline{X}_{ik})^2}$$

where D_{jk} is the interconcept distance,

$\overline{X}$ is the concept factor mean,

i is the factor,

j is concept j,

k is concept k,

m is the number of factors,

and it is assumed that factors are orthogonal.

[1] Osgood, p. 91

The researcher may scan the printed matrix to determine how distant in terms of factor means are various concepts from each other on each of the factors and in up to a three dimensional space.

IMPORTANCE

The processing system allowed the researcher to process large quantities of semantic differential data with an optimum economy while providing great freedom in the selection of concept orderings, scale orderings, and polarities.

The program enabled the researcher to determine the interconcept distances from data which was presented to respondents in up to forty different randomly ordered and polarized displays of the scales and concepts. The program also provides the option of punching subjects' responses in a standard order of concepts, scales, and polarities for input to other analysis systems. The system permitted the researcher to economically and efficiently utilze the semantic differential technique in the measurement of attitudes.

BIBLIOGRAPHY

Osgood, Charles E., Suci, George F., Tannenbaum, Percy H. The Measurement of Meaning, University of Illinois Press, Urbana, 1957

THE SCHOOL DISTRICT OF PHILADELPHIA
OFFICE OF RESEARCH AND EVALUATION

PAGE SORT

SEX

GRADE

PAGE CODE

PUPIL CODE

TREATMENT CODE

MORE LIKE | NEITHER | MORE LIKE

MORE LIKE | NEITHER | MORE LIKE

MORE LIKE | NEITHER | MORE LIKE

MORE LIKE | NEITHER | MORE LIKE

THE SCHOOL DISTRICT OF PHILADELPHIA

OFFICE OF RESEARCH AND EVALUATION

PAGE SORT

SEX

GRADE

PAGE CODE

PUPIL CODE

TREATMENT CODE

VERY | SORT OF | NEITHER | SORT OF | VERY

VERY | SORT OF | NEITHER | SORT OF | VERY

VERY | SORT OF | NEITHER | SORT OF | VERY

VERY | SORT OF | NEITHER | SORT OF | VERY

DC 5459

THE SCHOOL DISTRICT OF PHILADELPHIA

OFFICE OF RESEARCH AND EVALUATION

PAGE SORT

SEX

GRADE

PAGE CODE

PUPIL CODE

TREATMENT CODE

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

DC 5460

THE SCHOOL DISTRICT OF PHILADELPHIA
OFFICE OF RESEARCH AND EVALUATION

PAGE SORT | SEX | GRADE | PAGE CODE | PUPIL CODE | TREATMENT CODE

AGNEW

	EXTREMELY	QUITE	SLIGHTLY	NEITHER	SLIGHTLY	QUITE	EXTREMELY	
passive								active
potent								puny
bad								good
sluggish								speedy
weak								strong
awful								nice
sweet								sour
arge								small
low								fast

McGOVERN

	EXTREMELY	QUITE	SLIGHTLY	NEITHER	SLIGHTLY	QUITE	EXTREMELY	
sluggish								SPEEdy
passive								active
slow								fast
small								large
puny								potent
weak								strong
sour								sweet
awful								nice
bad								good

A Liberal Politician

	EXTREMELY	QUITE	SLIGHTLY	NEITHER	SLIGHTLY	QUITE	EXTREMELY	
ctive								passive
ad								good
trong								weak
weet								sour
low								fast
mall								large
ice								awful
peedy								sluggish
uny								potent

A Conservative Politician

	EXTREMELY	QUITE	SLIGHTLY	NEITHER	SLIGHTLY	QUITE	EXTREMELY	
potent								puny
passive								active
sluggish								speedy
good								bad
awful								nice
weak								strong
large								small
sour								sweet
fast								slow

PAGE SORT

SEX

GRADE

PAGE CODE

PUPIL CODE

TREATMENT CODE

A Liberal

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

good	bad
nice	awful
sweet	sour
strong	weak
potent	puny
large	small
fast	slow
active	passive
speedy	sluggish

A Conservative

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

potent	puny
sluggish	speedy
awful	nice
large	small
fast	slow
sour	sweet
weak	strong
good	bad
passive	active

McGovern

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

puny	potent
active	passive
speedy	sluggish
bad	good
nice	awful
strong	weak
small	large
sweet	sour
slow	fast

AGNEW

EXTREMELY QUITE SLIGHTLY NEITHER SLIGHTLY QUITE EXTREMELY

fast	slow
small	large
sour	sweet
nice	awful
strong	weak
speedy	sluggish
good	bad
puny	potent
active	passive

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A SEMANTIC DIFFERENTIAL PROCESSING SYSTEM

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          AMERICAN EDUCATIONAL RESEARCH ASSOCIATION
          CHICAGO, ILLINOIS
          APRIL, 1972

--EXAMPLE PROBLEM--

     THIS PROBLEM HAS FOUR CONCEPTS, TWO PAGE FORMS WITH RANDOM
REORDERING OF CONCEPTS, SCALES, AND SCALE POLARITIES.

THERE ARE NINE SCALES, THREE IN EACH DIMENSION--

      *    ----------    **    -------      **    --------     *
      *    EVALUATION    **    POTENCY      **    ACTIVITY     *
      * BAD         GOOD ** WEAK     STRONG ** SLOW        FAST *
      * AWFUL       NICE ** PUNY     POTENT ** PASSIVE   ACTIVE *
      * SOUR       SWEET ** SMALL     LARGE ** SLUGGISH  SPEEDY *

- - - - - - - - - - - - - - - -INPUT DATA LISTED BELOW- - - - - - - - - - - - - -

1232 1111 1111 L 101621251776 333444566 172266126 255626324          7J
1232 2222 1111 L 101721221772 676656566 162366216 611622626          7J
1221 3333 1111 L 201541321711 455445466 363444345 444353444          7J
1241 4444 1111 L 201712673435 777676777 171367147 443723333          7J
1222 5555 2222 L 202264234223 434434432 434643444 454664641          7J
1232 6666 2222 L 102323236322 535254533 522545335 255322252          7J
1221 7777 2222 L 202234122322 266224227 712721726 711777717          7J
1231 8888 2222 L 102111564655 213553656 357537222 171611661          7J
LAST COMMENT CARD
```

```
THE PARAMETERS FOR THIS PROBLEM ARE:

  4 CONCEPTS,        9 SCALES,        3 FACTORS.

THE SCALE LENGTH IS    7

THERE ARE   8 OBSERVATIONS.

               3 SCALES IN FACTOR ONE.

               3 SCALES IN FACTOR TWO.

               3 SCALES IN FACTOR THREE.

               2 PAGE FORMS.

OPTION ONE IS   1 OPTION TWO IS   0 OPTION THREE IS   2

THERE ARE   1 CARDS FOR EACH OBSERVATION.


          THE SCALES FOR THIS PROBLEM ARE--

 BDGOOD    AWFNCE    SRSWET    WKSTRG    PNPTNT    SMLRGE    SLFAST    PASACT    SLGSPD


          THE CONCEPTS FOR THIS PROBLEM ARE--

 LIBERL    CNSRVT    MCGOVR    AGNEW


          THE FACTORS FOR THIS PROBLEM ARE--

 EVALUA    POTNCY    ACTIVI


THE PAGE SORT FORMS LOOK LIKE THIS--
4  3  1  2  8 -5  1  9  4  2 -3 -6  7  9  8  7  6  5  4  3  2  1 -8  1 -4 -3  7  6 -2 -9  5 -5  8  9 -1  2  4 -6  3 -7
1  2  3  4 -1 -2 -3 -4 -5 -6 -7 -8 -9 -5  9  2 -6 -7  3  4 -1 -8  5 -8 -9  1 -2 -4  6 -3  7 -7  6  3 -3 -4 -9 -1  5 -8
1000 LOOP COMPLETED

DATA WITH ALL CASES AND DIVIDED BY NOBS LOOKS LIKE--
NOBS=     8

 6.25000   5.62500   5.00000   5.75000   5.25000   4.87500   5.00000   5.87500   5.12500

 3.62500   3.62500   3.25000   3.87500   4.37500   4.37500   4.00000   3.50000   3.25000

 6.00000   5.50000   5.25000   4.62500   4.87500   4.50000   4.75000   5.37500   4.62500

 2.00000   0.75000   2.12500   4.00000   4.87500   4.00000   4.00000   5.75000   3.87500
```

CONCEPT MEANS FOR EACH FACTOR

	FACTOR EVALUA	FACTOR POTNCY	FACTOR ACTIVI
CONCEPT LIBERL	5.6250	5.2917	5.3333
CONCEPT CNSRVT	3.5000	4.2083	3.5833
CONCEPT MCGOVR	5.5833	4.6667	4.9167
CONCEPT AGNEW	1.6250	4.2917	4.5417

```
OSGOOD D-MATRIX FOR FACTOR NUMBEREVALUA
CONCEPT
LIBERL
   0.000000    2.125000    0.541667    4.000000
CONCEPT
CNSRVT
   4.515625    0.000000   -2.083333    1.875000
CONCEPT
MCGOVR
   0.001736    4.340276    0.000000    3.958333
CONCEPT
AGNEW
  16.000000    3.515625   15.668390    0.000000
```

```
OSGOOD D-MATRIX FOR FACTOR NUMBERPCTNCY
CONCEPT
LIBERL
   0.000000    1.083333    0.625000    1.000000
CONCEPT
CNSRVT
   5.689235    0.000000   -0.458333   -0.083333
CONCEPT
MCGOVR
   0.392361    4.550344    0.000000    0.375000
CONCEPT
AGNEW
  17.000000    3.522569   15.809020    0.000000
```

```
OSGOOD D-MATRIX FOR FACTOR NUMBERACTIVI
CONCEPT
LIBERL
   0.000000    1.750000    0.416667    0.791667
CONCEPT
CNSRVT
   8.751735    0.000000   -1.333333   -0.958333
CONCEPT
MCGOVR
   0.565972    6.328121    0.000000    0.375000
CONCEPT
AGNEW
  17.626720    4.440970   15.949640    0.000000
```



```
OSGOOD D MATRIX FOR SEMANTIC SPACE WITH DIMENSIONALITY OF THE NUMBER OF FACTORS.
CONCEPT
LIBERL
   0.000000    1.750000    0.416667    0.791667
CONCEPT
CNSRVT
   2.958333    0.000000   -1.333333   -0.958333
CONCEPT
MCGOVR
   0.752311    2.515575    0.000000    0.375000
CONCEPT
AGNEW
   4.198415    2.107361    3.993701    0.000000
```

FINISH OF EXAMPLE PROBLEM.

```
FINISH CARD HAS BEEN ENCOUNTERED
   END OF THIS PROBLEM RUN
COMNT VERSION 12/07/70

CORE USAGE        OBJECT CODE=   27696 BYTES,ARRAY AREA=   10212 BYTES,TOTAL AREA AVAILABLE=  147872  BYTES

DIAGNOSTICS         NUMBER OF ERRORS=        0, NUMBER OF WARNINGS=       7, NUMBER OF EXTENSIONS=        0

COMPILE TIME=     2.11 SEC,EXECUTION TIME=      1.49 SEC,   WATFIV - VERSION 1 LEVEL 3 MARCH  1971       DATE=  72/080
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*                                                                       *
*                                                                       *
*                    SCHOOL DISTRICT OF PHILADELPHIA                    *
*                  OFFICE OF RESEARCH AND EVALUATION                    *
*                             DATA ANALYSIS                             *
*                                                                       *
*                                                                       *
*                INFORMATION ABOUT THE PROGRAM WHICH                    *
*                   PRODUCED THE ATTACHED OUTPUT                        *
*                       MAY BE OBTAINED FROM                            *
*                                                                       *
*                                                                       *
*              MR. ELLERY M. PIERSON                                    *
*              RESEARCH ASSOCIATE FOR DESIGN AND ANALYSIS               *
*              ROOM 401                                                 *
*              SCHOOL DISTRICT OF PHILADELPHIA                          *
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*              PHILADELPHIA, PENNSYLVANIA 19103                         *
*                                                                       *
*                                                                       *
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